



UNIVERSITI PUTRA MALAYSIA

**COMPARATIVE STUDIES IN RUMEN ACTIVITIES AND UREA
KINETICS BETWEEN CATTLE AND BUFFALOES**

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**COMPARATIVE STUDIES IN RUMEN ACTIVITIES AND UREA
KINETICS BETWEEN CATTLE AND BUFFALOES**

by

NORHANI BT. ABDULLAH

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TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	ii
LIST OF TABLES	viii
LIST OF FIGURES	xi
ABSTRACT	xvi
ABSTRAK	xix
INTRODUCTION	1
CHAPTER 1 LITERATURE REVIEW	3
Livestock Production	3
Buffalo and Cattle	3
Integrated Livestock Farming	7
Agricultural By-products as Feed Materials	9
Ruminant Nutrition	12
Balance of Nutrients	12
Requirements for Glucose and Dietary Fat	14
Rumen Microbial Populations	16
Microbial Compartments	16
Microbial Variation and Fermentation	19
The Role of Protozoa in Rumen Digestion	21
The Role of Rumen Fungi in Fibre Digestion	23
Urea-Nitrogen Metabolism	25
Nitrogen Metabolism in the Rumen	25
Transfer of Urea from Blood to the Rumen	27



	PAGE
Microbial Requirements for Nitrogen and Sulphur	28
Fibre Utilization by Cattle and Buffaloes	30
CHAPTER 2 RUMEN FERMENTATION AND FEED DEGRADATION, FLUID VOLUME AND PASSAGE RATE OF SMALL PARTICLES IN CATTLE AND BUFFALOES	33
Introduction	33
Materials and Methods	36
Animals	36
Experimentation	37
Statistical analyses	51
Results	52
Fermentation Activity	52
Degradability of Feed Samples	70
Rumen Fluid Volume and Passage Rate of Small Particles	78
Discussion	87
CHAPTER 3 COLONIZATION AND DIGESTION OF FEED PARTICLES BY RUMEN MICROBES IN CATTLE AND BUFFALOES	101
Introduction	101
Materials and Methods	104
Preparation of Samples Incubated in the Rumen	106
Fixing and Staining of Protozoa	107
Processing of Samples for SEM	108
Results	109
Rumen Liquor Protozoa	109



	PAGE
Morphology of Bacteria and Fungi on Rumen Digesta	115
Feed Colonization and Degradation by Rumen Bacteria ...	126
Feed Colonization and Degradation by Rumen Fungi	141
Control Samples	162
Discussion	162
 CHAPTER 4 STUDIES ON UREASE ACTIVITY AND EPITHELIAL BACTERIA IN THE GASTROINTESTINAL TRACT OF CATTLE AND BUFFALOES	 178
Introduction	178
Materials and Methods	180
Animals and Diets	180
Urease Activity Assay	183
Rumen Measurements and Characteristics of Rumen Liquor	185
Tissue Surface Bacteria	186
Statistical Analyses	189
Results	190
Rumen Size, Characteristics of Rumen Liquor and Urease Activity in Slaughtered Animals	190
Characteristics of Rumen Liquor and Urease Activity in Fistulated Cattle and Buffaloes Fed Guinea Grass ...	207
Urease Activity in Fistulated Cattle and Buffaloes Fed Straw Diets	210
Regression Analyses on Urease Activity and NH ₃ Concentration	211
Tissue Surface Bacteria	212
Discussion	238

	PAGE
CHAPTER 5 A STUDY ON FACTORS AFFECTING UREA TRANSFER TO THE DIGESTIVE TRACT IN CATTLE AND BUFFALOES	256
Introduction	256
Materials and Methods	257
Animals and Diets	258
Procedures for Urea Kinetics Studies	259
Chemical Analyses of Feed Materials	268
Characteristics of Rumen Liquor	269
Definitions of Terminologies	269
Calculations	274
Statistical Analyses	275
Results	276
Urea Kinetics Study in Cattle and Buffaloes Fed Guinea Grass	276
Urea Kinetics Study in Cattle and Buffaloes Fed Straw Diets	283
Regression Analyses on Urea Kinetics	292
Discussion	299
CHAPTER 6 GENERAL DISCUSSION	310
REFERENCES	318
APPENDICES	344



LIST OF TABLES

TABLE		PAGE
1	DEGRADATION RATES AND POTENTIAL DEGRADABILITY (48 h) OF DM, N AND NDF COMPONENTS OF GUINEA GRASS INCUBATED IN ANIMALS FED GUINEA GRASS	72
2	DEGRADATION RATES AND POTENTIAL DEGRADABILITY (48 h) OF STRAW DM INCUBATED IN ANIMALS FED GUINEA GRASS	74
3	DEGRADATION RATES AND POTENTIAL DEGRADABILITY (48 h) OF STRAW DM IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	77
4	COMPARATIVE DEGRADATION RATES AND POTENTIAL DEGRADABILITY (48 h) OF STRAW DM BETWEEN ANIMALS FED GRASS OR STRAW	77
5	LIVWEIGHT, WATER INTAKE, RUMEN FLUID VOLUME, FLUID OUTFLOW RATES AND MRT IN CATTLE AND BUFFALOES	80
6	FEED INTAKE, PASSAGE RATE CONSTANTS, MRT, POOL SIZE AND OUTFLOW RATE OF PARTICLES, FROM RUMEN SAMPLING IN CATTLE AND BUFFALOES	82
7	FEED INTAKE, PASSAGE RATE CONSTANTS AND MRT OF PARTICLES FROM RECTAL SAMPLING IN CATTLE AND BUFFALOES	84
8	FEED AND WATER INTAKE, PASSAGE RATE CONSTANT AND RUMEN MRT OF PARTICLES FROM BOTH SAMPLING PROCEDURES	85
9	RESULTS OF T-TEST ANALYSIS ON LIQUID AND PARTICLES FLOW RATE CONSTANTS, MRT AND METHODS OF SAMPLING	86
10	LIVWEIGHT, RUMEN SIZE AND CHARACTERISTICS OF RUMEN LIQUOR IN CATTLE AND BUFFALOES ON <u>SETARIA</u> AND PPF-BASED DIET (FIRST EXPERIMENT)	191
11	DISTRIBUTION OF UREASE ACTIVITY IN CATTLE AND BUFFALOES GRAZING <u>SETARIA</u> AND PPF-BASED DIET (FIRST EXPERIMENT)	193



TABLE		PAGE
12	DISTRIBUTION OF UREASE ACTIVITY IN KK AND LID CATTLE STALL - FED WITH <u>SETARIA</u> (FIRST EXPERIMENT)	196
13	LIVWEIGHT, RUMEN SIZE, CHARACTERISTICS OF RUMEN LIQUOR IN CATTLE AND BUFFALOES STALL-FED WITH GUINEA GRASS (SECOND EXPERIMENT)	197
14	DISTRIBUTION OF UREASE ACTIVITY IN MALE AND FEMALE CATTLE AND BUFFALOES STALL - FED WITH GUINEA GRASS (SECOND EXPERIMENT)	198
15	LIVWEIGHT, RUMEN SIZE AND CHARACTERISTICS OF RUMEN LIQUOR IN KK CATTLE GRAZING <u>SETARIA</u> (S) OR SUPPLEMENTED WITH MINERALS (M) OR PALM KERNEL CAKE (PKC) OR BOTH (M+PKC) (THIRD EXPERIMENT)	201
16	DISTRIBUTION OF UREASE ACTIVITY IN KK CATTLE GRAZING <u>SETARIA</u> (S) OR SUPPLEMENTED WITH MINERALS (M) OR PALM KERNEL CAKE (PKC) OR BOTH (M+PKC) (THIRD EXPERIMENT)	203
17	LIVWEIGHT, RUMEN SIZE AND CHARACTERISTICS OF RUMEN LIQUOR IN DROUGHTMASTER CATTLE FED PALM KERNEL CAKE-BASED DIET (FOURTH EXPERIMENT)	205
18	DISTRIBUTION OF UREASE ACTIVITY IN DROUGHT-MASTER CATTLE FED PALM KERNEL CAKE-BASED DIET (FOURTH EXPERIMENT)	206
19	UREASE ACTIVITY OF RUMEN LIQUOR BACTERIA IN FISTULATED CATTLE AND BUFFALOES FED STRAW WITH OR WITHOUT MOLASSES SAMPLED ONCE BEFORE FEEDING	211
20	REGRESSION ANALYSES OF RUMEN NH_3 AND UREASE ACTIVITY IN CATTLE AND BUFFALOES FED GRASS	212
21	BACTERIAL POPULATION SCORE AND DISTRIBUTION PATTERN IN THE GIT OF CATTLE AND BUFFALOES FROM THE FIRST EXPERIMENT	218
22	FEED COMPOSITION IN % DRY MATTER	269

TABLE		PAGE
23	LIVEWEIGHT, DM, OM, N AND WATER INTAKE, URINE OUTPUT AND CHARACTERISTICS OF RUMEN LIQUOR OF CATTLE AND BUFFALOES FED GUINEA GRASS	
24	PLASMA UREA, UREA AND CARBON KINETICS IN ANIMALS FED GUINEA GRASS	282
25	LIVEWEIGHT, DM, OM, N AND WATER INTAKES AND URINE OUTPUT IN CATTLE AND BUFFALOES FED EITHER STRAW (S) OR STRAW + MOLASSES (SM)	284
26	EFFECTS OF PERIODS, SPECIES AND DIETS ON PLASMA UREA AND UREA KINETICS	289
27	EFFECTS OF PERIODS, SPECIES AND DIETS ON RUMEN CARBON KINETICS	293
28	CORRELATION COEFFICIENTS	293

LIST OF FIGURES

FIGURE		PAGE
1	NITROGEN TRANSACTIONS IN THE RUMEN	26
2	RUMEN LIQUOR pH IN CATTLE AND BUFFALOES FED GUINEA GRASS	53
3	RUMEN LIQUOR pH IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	54
4	RUMEN NH ₃ IN CATTLE AND BUFFALOES FED GUINEA GRASS	56
5	RUMEN NH ₃ IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	57
6	RUMEN NH ₃ IN CATTLE AND BUFFALOES FED BOTH STRAW AND STRAW + MOLASSES	59
7	TOTAL RUMEN VFA IN CATTLE AND BUFFALOES FED GUINEA GRASS	60
8	MOLAR PERCENT ACETATE, PROPIONATE AND BUTYRATE IN CATTLE AND BUFFALOES FED GUINEA GRASS	61
9	TOTAL RUMEN VFA IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	63
10	TOTAL RUMEN VFA IN CATTLE AND BUFFALOES FED BOTH STRAW AND STRAW + MOLASSES	64
11	TOTAL RUMEN VFA FOR STRAW AND STRAW + MOLASSES DIETS	65
12	MOLAR PERCENT ACETATE IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	66
13	MOLAR PERCENT PROPIONATE IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	68
14	MOLAR PERCENT BUTYRATE IN CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	69
15	PERCENTAGE LOSS OF DM, NITROGEN AND NDF OF GUINEA GRASS INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	71



FIGURE		PAGE
16	PERCENTAGE LOSS IN DM OF STRAW, TREATED AND UNTREATED PPF INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	73
17	PERCENTAGE LOSS IN DM OF STRAW INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED STRAW OR STRAW + MOLASSES	75
18	DILUTION CURVE FOR Co IN RUMEN LIQUOR OF A BUFFALO FED STRAW	79
19	DILUTION CURVE FOR Cr IN RUMEN DIGESTA OF A BUFFALO FED STRAW	81
20	DILUTION CURVE FOR Cr IN RECTAL DIGESTA OF A BUFFALO FED STRAW	83
21	CILIATE PROTOZOA IN RUMEN LIQUOR OF CATTLE AND BUFFALOES (A--H)	111
22	SEM OF RUMEN DIGESTA FROM SLAUGHTERED CATTLE AND BUFFALOES FED <u>SETARIA</u>	116
23	SEM OF PPF FRAGMENTS	119
24	SEM OF BACTERIAL POPULATIONS ON PARTIALLY DIGESTED GUINEA GRASS FRAGMENTS COLLECTED FROM FISTULATED ANIMALS BEFORE FEEDING IN THE MORNING	121
25	SEM OF RUMEN FUNGI ON GUINEA GRASS COLLECTED FROM FISTULATED CATTLE AND BUFFALOES BEFORE FEEDING IN THE MORNING	124
26	SEM OF GUINEA GRASS AFTER INCUBATION IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	128
27	SEM OF GUINEA GRASS FRAGMENTS AT 24 h AFTER INCUBATION IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	130
28	SEM OF STRAW FRAGMENTS UNINCUBATED AND INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	134



FIGURE		PAGE
29	SEM OF STRAW FRAGMENTS INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED STRAW	137
30	SEM OF PPF FRAGMENTS INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	139
31	SEM OF FUNGAL ATTACHMENT ON GUINEA GRASS	144
32	SEM (EXCEPT FIGURE 32 F) OF PENETRATING STRUCTURES OR 'APPRESORIA' PRODUCED BY THE FUNGI ON GRASS AND STRAW FRAGMENTS INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES	145
33	SEM OF SPORANGIA ON GUINEA GRASS AND STRAW FRAGMENTS	146
34	SEM OF SMALL OVOID SPORANGIA ON GUINEA GRASS AND STRAW FRAGMENTS	152
35	STRUCTURES THAT RESEMBLED WARTY SPORES ON GUINEA GRASS AND STRAW FRAGMENTS 48 h AFTER INCUBATION IN THE BUFFALO RUMEN	154
36	SEM OF FUNGAL DEVELOPMENT ON PPF INCUBATED IN THE RUMEN OF CATTLE AND BUFFALOES FED GUINEA GRASS	159
37	DIAGRAMMATIC REPRESENTATION OF THE RETICULO-RUMEN FROM THE LEFT SIDE AND OTHER PARTS OF THE GIT INDICATING TISSUE SAMPLING SITES	184
38	NH ₃ CONCENTRATION AND UREASE ACTIVITY OF RUMEN LIQUOR BACTERIA IN FISTULATED CATTLE FED GUINEA GRASS	208
39	NH ₃ CONCENTRATION AND UREASE ACTIVITY OF RUMEN LIQUOR BACTERIA IN FISTULATED BUFFALOES FED GUINEA GRASS	209
40	SEM OF BACTERIAL ATTACHMENT ON EPITHELIAL TISSUE SURFACE	213
41	SEM OF DIFFERENT BACTERIAL POPULATION DENSITIES USED AS REFERENCES TO DETERMINE POPULATION SCORES	216

FIGURE		PAGE
42	SEM OF EPITHELIAL TISSUE SURFACES OF KK CATTLE GRAZING <u>SETARIA</u>	221
43	SEM OF EPITHELIAL TISSUE SURFACES OF KK CATTLE AND BUFFALOES GRAZING <u>SETARIA</u>	223
44	SEM OF EPITHELIAL TISSUE SURFACES OF KK CATTLE STALL-FED WITH <u>SETARIA</u>	226
45	SEM OF EPITHELIAL TISSUE SURFACES OF LID CATTLE STALL-FED WITH <u>SETARIA</u>	228
46	SEM OF EPITHELIAL TISSUE SURFACES OF KK CATTLE FED PPF-BASED DIET	231
47	SEM OF EPITHELIAL TISSUE SURFACES FROM BUFFALOES FED PPF-BASED DIET	233
48	TEM OF EPITHELIAL SURFACE FROM THE DORSAL SAC OF THE RUMEN OF BUFFALO GRAZED ON <u>SETARIA</u> . THE UPPER CELLS WERE HEAVILY KERATINIZED	234
49	TEM OF STRATIFIED SQUAMOUS EPITHELIUM FROM THE DORSAL SURFACE OF THE CAUDAL PILLAR OF BUFFALO GRAZED ON <u>SETARIA</u> SHOWING A HETEROGENOUS POPULATION OF BACTERIA ON THE SURFACE	236
50	TEM OF THE SURFACE OF A DEGENERATIVE EPITHELIAL CELL FROM THE VENTRAL RETICULUM OF CATTLE GRAZED ON <u>SETARIA</u> SHOWING A HETEROGENOUS POPULATION OF BACTERIA AND THE VARYING RUTHENIUM - RED STAINING SLIME TYPES	237
51	TEM OF EPITHELIAL SURFACE FROM THE VENTRAL RETICULUM OF CATTLE GRAZED ON <u>SETARIA</u> SHOWING A NUMBER OF BACTERIA AND THE RUTHENIUM - RED STAINING SLIMES THAT INTERACT WITH THE TISSUE SURFACE	239
52	PLASMA UREA - N OF CATTLE AND BUFFALOES FED GUINEA GRASS AT DIFFERENT SAMPLING TIMES AFTER ¹⁴ C-UREA ADMINISTRATION	278

FIGURE		PAGE
53	SPECIFIC RADIOACTIVITY OF ^{14}C -UREA AND ^{14}C - BICARBONATE IN A BUFFALO	286
54	PLASMA UREA - N IN CATTLE AND BUFFALOES FED STRAW (S) OR STRAW + MOLASSES (SM) AT DIFFERENT SAMPLING TIMES AFTER ^{14}C -UREA ADMINISTRATION (FIRST PERIOD)	287
55	PLASMA UREA - N IN CATTLE AND BUFFALOES FED STRAW (S) OR STRAW + MOLASSES (SM) AT DIFFERENT SAMPLING TIMES AFTER ^{14}C -UREA ADMINISTRATION (SECOND PERIOD)	288
56	THE RELATIONSHIP BETWEEN RATE OF UREA SYNTHESIS AND RATE OF UREA DEGRADATION IN CATTLE AND BUFFALOES FED STRAW-BASED DIETS	295
57	THE RELATIONSHIP BETWEEN RATE OF UREA TRANSFER TO THE RUMEN AND PLASMA UREA - N IN CATTLE AND BUFFALOES FED GUINEA GRASS OR STRAW-BASED DIETS	296
58	THE RELATIONSHIP BETWEEN PLASMA UREA - N AND RUMEN NH_3 CONCENTRATION IN CATTLE AND BUFFALOES FED GUINEA GRASS OR STRAW-BASED DIETS	297
59	THE RELATIONSHIP BETWEEN RATE OF UREA SYNTHESIS AND RUMEN NH_3 CONCENTRATION IN CATTLE AND BUFFALOES	298



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May 1989

Supervisors : Professor Mohd. Mahyuddin Bin Mohd. Dahan, Ph. D.

Professor Syed Jalaludin Bin Syed Salim, Ph. D.

Faculty : Veterinary Medicine and Animal Science.

Studies in rumen activities and urea kinetics were conducted to compare the digestion between cattle and buffaloes fed fibrous diets.

On straw-based diets, buffaloes demonstrated higher rate of rumen fermentation. The rumen pH of buffaloes (6.46 ± 0.02) was lower than cattle (6.78 ± 0.02), while the VFA concentration was higher than that of cattle (98.0 ± 2.2 versus 85.5 ± 1.6 mmol/l). The rumen ammonia was also found to be higher in buffaloes (4.00 ± 0.08 mg N/100 ml) than in cattle (3.55 ± 0.08 mg N/100 ml). The rate of degradation of straw was also faster in buffaloes ($0.018 \pm 0.003 \text{ h}^{-1}$) than in cattle ($0.010 \pm 0.004 \text{ h}^{-1}$). A similar trend was observed when the animals were fed guinea grass.



Voluntary feed intake and water consumption were similar for both species fed grass, but when fed straw, cattle showed higher feed intake and lower water consumption than buffaloes. There was no difference between cattle and buffaloes in the rate of passage of small feed particles from the rumen and rumen fluid volume based on liveweight was also not significantly different between the two animal species. However, the fluid outflow rate from the rumen was slower in the buffaloes (1.06 ± 0.19 l/h) than in the cattle (1.55 ± 0.01 l/h).

The rumen microbial population involved in digestion of feed materials in cattle and buffaloes was studied using Scanning Electron Microscopy. The morphology of the microorganisms, their mode of attachment and colonization on feed particles were found to be similar in both cattle and buffaloes. The predominant bacterial population colonizing grass and straw fragments consisted of rods and diplococci but in the case of palm press fibres (PPF) they were mainly rods. Fungi producing spherical sporangia and extensive rhizoidal system were more abundant on grass and straw fragments. They also produced multi-lobed vesicles or 'appresoria' for penetrating intact plant cell walls. Multiporous spherical sporangia were also observed. Fungi producing filiform or fusiform sporangia were more abundant on PPF fragments. Very few attached protozoa were seen.



The urease activity of bacteria in the rumen liquor as well as those on the epithelial surface was determined in cattle and buffaloes. The activity was not affected by the species of animals but was influenced by diet. It was also observed that ammonia concentration had no influence on urease activity. The activity was not evenly distributed in the gastrointestinal tract. In cattle and buffaloes fed grass, higher activity was recorded on tissues along the equatorial region of the rumen. The distribution of urease activity did not follow the population distribution pattern of the wall bacteria in both cattle and buffaloes. The enzyme produced by bacteria present in the rumen liquor as well as on the epithelial wall in both animal species was far in excess of the amount of endogenous urea transferred into the rumen.

The amount of urea transferred into the rumen was determined for both cattle and buffaloes when fed rice straw with and without molasses supplementation. Increasing soluble carbohydrate did not enhance urea transferred into the rumen. Buffaloes demonstrated higher urea transfer to the rumen (6.9 ± 2.2 g N/d) compared to cattle (2.9 ± 0.7 g N/d). The buffaloes also had lower urea synthesis rate from endogenous resources than the cattle.

Some of the results from the present study indicates differences in digestion between cattle and buffaloes fed fibrous diets.



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**KAJIAN PERBANDINGAN MENGENAI AKTIVITI RUMEN
SERTA KINETIK UREA DIANTARA LEMBU DAN KERBAU**

oleh

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May 1989

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Kajian mengenai aktiviti rumen dan kinetik urea telah dilakukan untuk membandingkan proses penghadaman oleh lembu dan kerbau yang diberi makanan berserabut.

Bila diberi makanan berdasarkan jerami padi, kerbau menunjukkan kadar fermentasi rumen yang tinggi. pH rumen kerbau (6.46 ± 0.02) adalah lebih rendah daripada lembu (6.78 ± 0.02), dan kepekatan asid lemak meruap (VFA) nya pula adalah lebih tinggi daripada lembu (98.0 ± 2.2 berbanding dengan 85.5 ± 1.6 mmol/l). Kepekatan ammonia rumen juga didapati lebih tinggi untuk kerbau (4.00 ± 0.08 mg N/100 ml) daripada untuk lembu (3.55 ± 0.08 mg N/100 ml). Kadar degradasi jerami untuk kerbau (0.018 ± 0.003 /jam) adalah lebih pantas daripada untuk lembu (0.010 ± 0.003 /jam). Trend yang sama dilihat bila haiwan-haiwan ini di beri makan rumput guinea.

Pengambilan makanan dan air adalah sama untuk kedua spesies bila diberi makan rumput, tetapi bila diberi jerami, pengambilan makanan adalah lebih tinggi dan pengambilan air lebih rendah untuk lembu daripada untuk kerbau. Tidak ada perbezaan diantara lembu dan kerbau dalam kadar pengaliran butir-butir kecil digesta daripada rumen dan isipadu bendalir rumen berdasarkan berat hidup juga tidak berbeza diantara kedua spesies haiwan. Kadar pengaliran keluar bendalir rumen adalah lebih perlahan untuk kerbau (1.06 ± 0.19 l/jam) daripada untuk lembu (1.55 ± 0.01 l/jam).

Pertumbuhan mikrob rumen yang terlibat dalam penghadaman bahan makanan lembu dan kerbau telah dikaji dengan kaedah 'Scanning Electron Microscope'. Perbezaan yang ketara tidak dilihat dalam jenis morfologi mikroorganisma, mod lekatan mikrob dan cara pertumbuhan koloni di butir-butir digesta diantara lembu dan kerbau. Bakteria yang predominan menumbuhkan rumput dan jerami padi terdiri daripada jenis rod dan diplokokoid, tetapi untuk serabut hampas buah kelapa sawit (PPF), kebanyakan nya ialah jenis rod. Kulat dengan sporangia berbentuk sfera dan sistem rizoid yang meluas dilihat di fragmen rumput dan jerami. Kulat juga membentuk struktur 'appresoria' untuk menembusi dinding sel tumbuhan. Sporangia berbentuk sfera yang berliang (lebih daripada satu) juga dilihat. Kulat yang mengeluarkan sporangia berbentuk filifom atau fusifom lebih banyak pada fragmen PPF. Hanya sedikit sahaja protozoa yang terlekat pada digesta rumen.

Aktiviti enzim urease bakteria dalam bendalir rumen dan bakteria pada permukaan tisu epitelia usus lembu dan kerbau telah dianggarkan. Aktiviti urease tidak berbeza diantara spesies haiwan tetapi dipengaruhi oleh diet yang berlainan. Kepekatan amonia rumen juga tidak menjejaskan aktiviti enzim. Penaburan aktiviti enzim tidak serata dalam usus penghadaman. Untuk lembu dan kerbau yang diberi makan rumput, aktiviti yang tinggi telah dilihat pada tisu yang diambil dibahagian tengah rumen. Penaburan aktiviti juga tidak selaras dengan corak penaburan pertumbuhan bakteria pada tisu dinding rumen lembu dan kerbau. Amonia enzim yang dikeluarkan oleh bakteria dalam bendalir rumen dan tisu dinding rumen untuk lembu dan kerbau adalah berlebihan daripada amonia urea endogen yang dipindahkan kedalam rumen.

Jumlah urea yang dikitar semula kedalam rumen telah dianggarkan untuk lembu dan kerbau yang diberi makan jerami padi \pm molasses. Penambahan karbohidrat larut tidak meningkatkan jumlah urea yang dipindahkan kedalam rumen. Kerbau menunjukkan pemindahan urea yang tinggi (6.9 ± 2.2 g N/hari) daripada lembu (2.9 ± 0.7 g N/hari). Kadar sintesis urea daripada sumber endogen juga adalah rendah untuk kerbau daripada untuk lembu.

Beberapa keputusan yang diperolehi daripada pengajian ini menunjukkan adanya perbezaan dalam proses penghadaman diantara lembu dan kerbau yang diberi makanan berserabut.

INTRODUCTION

Cattle (Bos indicus) and buffalo (Bubalus bubalis) production in Malaysia is carried out mainly by the smallholders particularly in the rice growing areas. The limited attention given to these animals so far has resulted in a slow development of the large ruminant livestock industry. Malaysia has to import about half of the total beef requirement and almost all of the dairy products consumed.

Slow growth in ruminant industry is mainly caused by inadequate supply of feeds and fodder. However, farm by-products such as rice straw and palm press fibre are abundantly available and have the potential use as animal feedstuffs.

The indigenous swamp buffalo and the local Kedah-Kelantan cattle are well adapted to the hot and humid environment. They have been found to be low producers but well suited to the production system that depends upon low quality feeding materials for the supply of nutrients.

The buffaloes are known to degrade fibrous diets better than cattle and several reasons for the difference have been suggested. Among the reasons given are that the buffaloes

have the ability to consume more feed, have a larger rumen volume, slower fluid outflow rate, slower passage rate of digesta, higher production of rumen ammonia, more efficient recycling of endogenous urea-N and a faster transfer of fine particles from the rumen.

However these information on the digestive efficiency of the buffaloes are inadequate to explain fully their superiority over cattle in utilizing low quality diet. There is thus a need to conduct comparative evaluation on the rumen environment and activities of these two species in order to obtain further information on the factors contributing to the superiority of the buffaloes in fibre digestion. The experiments carried out to achieve this objective include studies on rumen digestion, microbial population and colonization, bacterial urease activity and urea kinetics.

CHAPTER 1

LITERATURE REVIEW

Livestock Production

Buffalo and Cattle

Buffalo and cattle raising has traditionally been integrated into crop production system by Asian subsistence farmers, where draught animals play an important role in farm operations. Malaysia has a small number of large ruminants (0.5 million) compared to other South-East Asian nations like Indonesia, Thailand and the Philippines. In Java itself, there are over 1 million buffaloes and 3.8 million cattle (Petheram et al., 1985). In Thailand there are 6.1 million buffaloes and 4.5 million cattle (Wanapat, 1985) while the Philippines has about 3 million carabaos or swamp buffaloes (Momongan, 1985). The numbers quoted are only estimates and may vary with different authors. Nevertheless, the importance of these animals, especially the buffaloes for draft power, meat and milk productions is well recognised.

There are two main types of domestic buffaloes (Bubalus bubalis) based on their phenotypic characters, geographic distribution and wallowing habits. The 'River' buffaloes (with 50 diploid chromosome numbers) prefer clean running water while